County of San Diego

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June 12, 2002

TO: **Jack Miller**

FROM: **Kevin Heaton**

RE: **LIMITED HYDROLOGICAL STUDY OF THE CITUS AVENUE WATERSHED, ESCONDIDO, CALIFORNIA**

Please find attached the Limited Hydrological Study of the Citrus Avenue Watershed. The study provides a history of septic system failures in the watershed and has identified those areas that are considered to be impacted by shallow groundwater conditions. In general, the historical data indicates that septic systems constructed within 150 feet from the historic and/or existing natural or improved drainage have experienced failure failures.

The study provides an evaluation of three Scenarios that included current conditions, development of existing parcels and the projected maximum probable development of the watershed. This evaluation has is a projected an increase to watersheds groundwater recharge based on a maximum probable development of 28.1 acre-feet annually or 8.2% above current conditions.

It is recommended that the current moratorium be lifted under the following conditions:

- DEH develop and implement a groundwater-monitoring and testing program to provide long-term groundwater information to assist the evaluation of future development proposals.

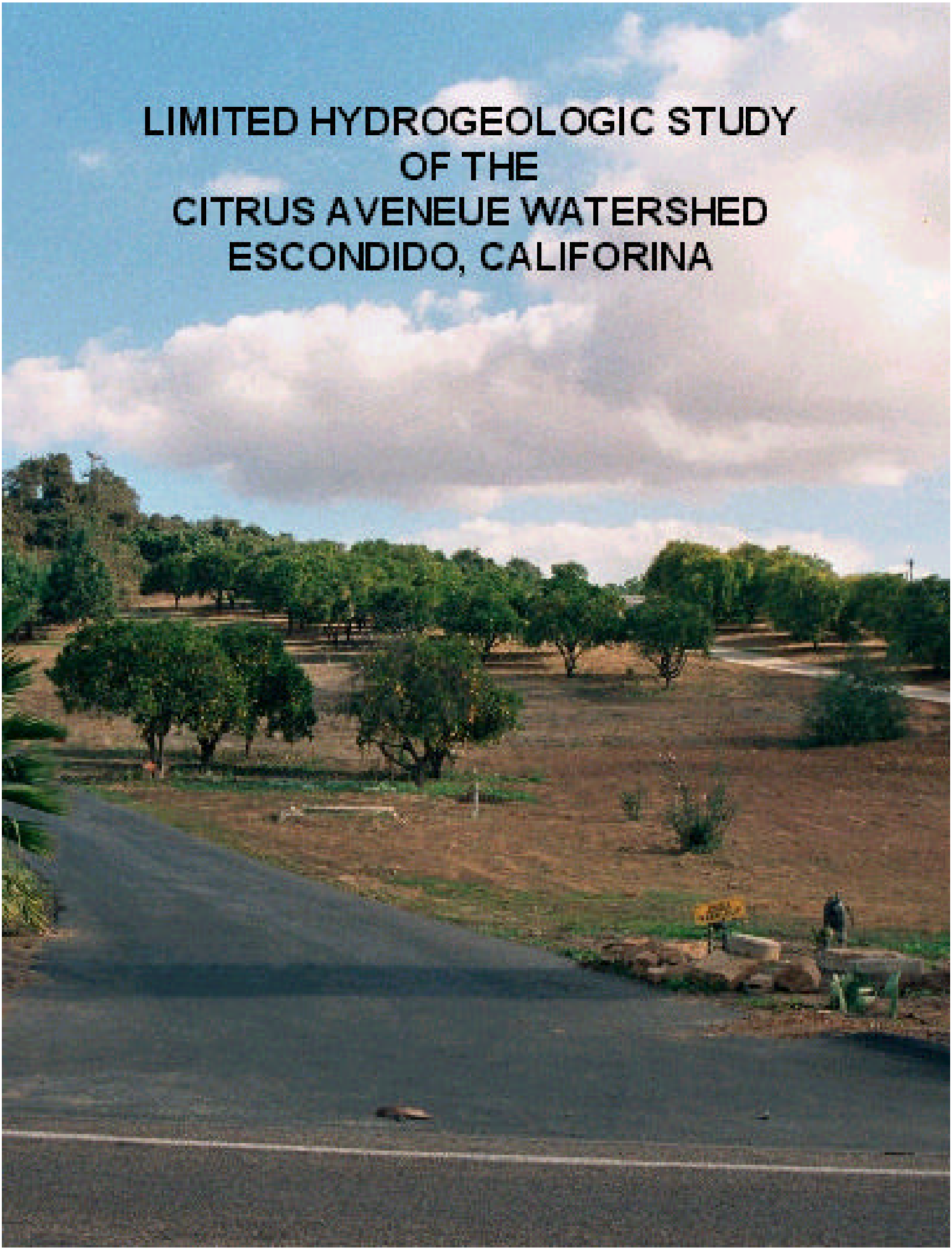
- DEH should strictly enforcement of the groundwater separation requirements on all new septic systems within the watershed.

- Consider allowing mound systems as an alternative to a septic system to achieve a proper groundwater separation.

- Improve and/or modify the current surface drainage structures along both Bear Valley Parkway and Citrus Avenue to prevent runoff infiltration and to reduce the potential of flooding in the area of the existing septic systems that have experienced failures.

Based on the study the developed lots that have had historical problems with septic system failures are expected to continue to have failures unless a long-term solution can be implemented. Currently the only long-term solution for these developed lots currently are being in public sewer.

LIMITED HYDROGEOLOGIC STUDY OF THE CITRUS AVENEUE WATERSHED ESCONDIDO, CALIFORINA



LIMITED HYDROLOGICAL STUDY
OF THE
CITUS AVENUE WATERSHED
ESCONDIDO, CALIFORINA

Staff Report

by

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June 12, 2002

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1. INTRODUCTION

The County of San Diego, Department of Environmental Health (DEH) has completed a Limited Hydrogeologic Study of the Citrus Avenue Moratorium area. This moratorium was implemented to restrict new development in the area due to septic system failures caused by high groundwater conditions. The Board of Supervisors established this moratorium in 1982 at the recommendation of the Department of Health Services, Division of Environmental Health. The intent of this study was to determine if the scope of the existing moratorium should be modified or lifted.

2. GENERAL BACKGROUND

In the late 1970's San Diego County experienced several years of above average rainfall, which resulted in numerous areas of the county experiencing failed septic systems due to high groundwater conditions. In most areas of the county, these problems were localized and repairs corrected the system failures. In several areas the high groundwater problem was much more extensive and system repairs were not possible or effective.

As a result of the high groundwater conditions, on January 17, 1980, the Department implemented stricter requirements for demonstration of groundwater separation and more comprehensive site evaluations. Following the implementation of these requirements, on February 5, 1980, the Board of Supervisors appointed a technical committee to evaluate septic system issues in San Diego County. This committee evaluated three areas related to septic systems and on-site waste disposal. These areas were:

- High groundwater and septic effluent accumulation,
- Septic system criteria and policy, and
- New technologies for on-site waste disposal systems.

The committee released its report in July of 1982. This report provided the committee's recommendations on groundwater separation and the use of alternative systems as a repair to failing systems. These recommendations were incorporated into the Department's septic system policies and procedures.

The July 1982 report identified two types of septic system failures:
Physical Failure - A physical septic system failure is when untreated effluent discharging directly to the ground surface or the sewage backs up into the house. This type of failure occurs when the capacity of the soil to transmit wastewater from the leachlines has been exceeded. This type of failure can be caused by:

- Improper or unrepresentative percolation testing prior to system construction.
- Inadequate design of the septic system.
- Compaction of the soils in the leachfield area by excavating equipment.
- Clogging of the subsurface soils by fine soil particles.
- Clogging of the subsurface soils by suspended solids in the wastewater.
- Deflocculation of clays by high sodium waters from water softeners.
- Buildup of an organic mat at the liquid-soil interface in the leachfield.
- Rise of the water table to the level of the leachlines.

The failures caused by the rise in the water table into the leach field are the only failure that cannot be corrected by a repair.

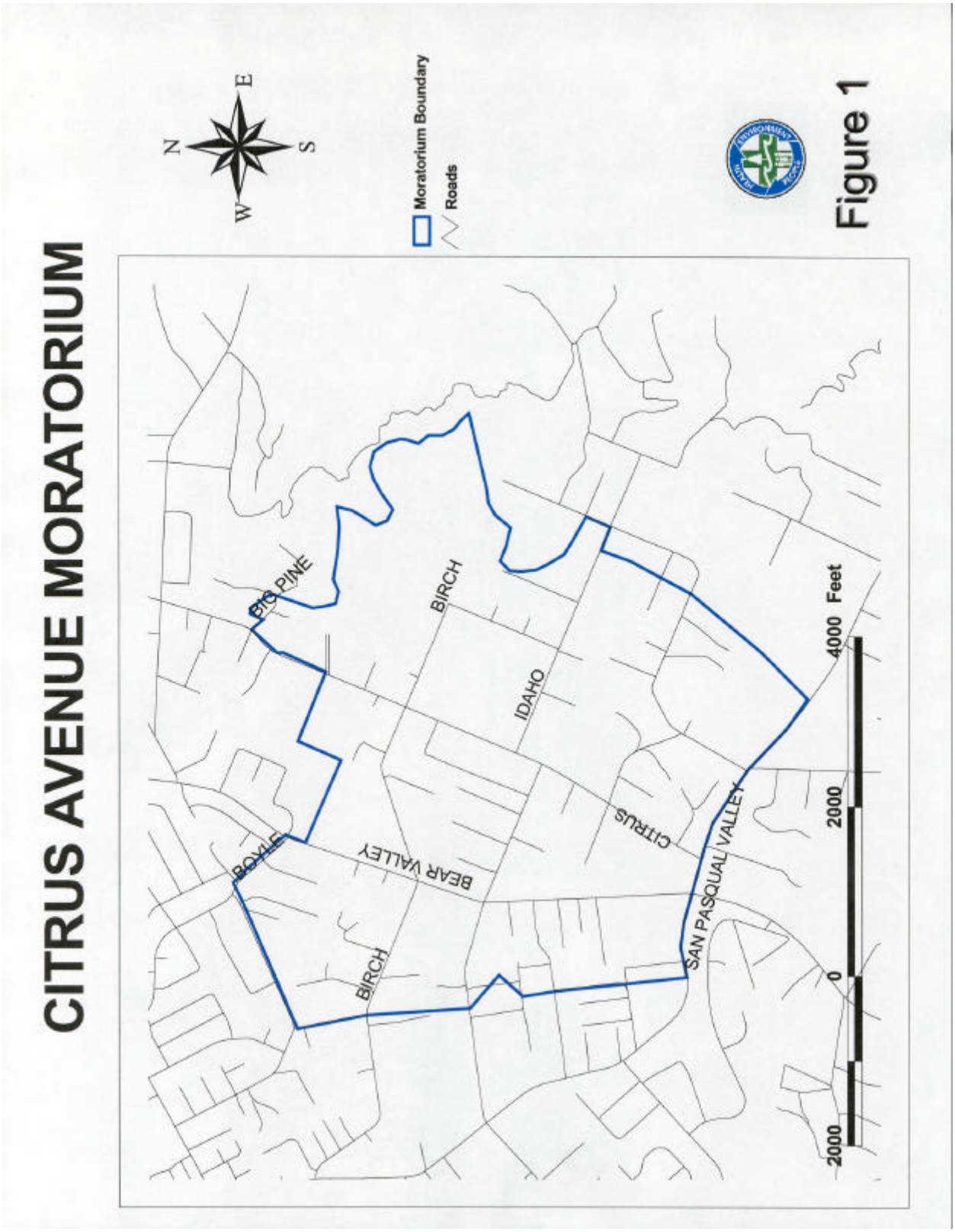
Technical Failure - A technical septic system failure is when conditions are such that the water table rises to within five feet of the bottom of the septic system disposal field. A minimum of a 5-foot separation is required to prevent the underlain groundwater and nearby surface waters from being contaminated by virus and bacteria that are in the wastewater.

2.1 Citrus Avenue Moratorium Background

In the late 1970's, the Citrus Avenue area experienced numerous septic system failures. These failures were documented by DEH in the drainage areas along Bear Valley Parkway and Citrus Avenue (Figure 1). This area is located in the unincorporated area of southeastern Escondido. These failures were poorly documented and the records are limited. Table 1 provides a summary of the documented failures in the moratorium area prior to 1982. These failures are considered to be primary due to shallow groundwater conditions.

In 1982 due to a large number of septic system failures along Citrus Avenue, DEH completed a survey of the area. This survey included a detailed evaluation of approximately 600 parcels in the area. The survey determined that high groundwater conditions were the primary cause of the failing septic systems. Based on this survey, it is estimated that there are at least two unreported failures in the area for each reported failure.

Following the 1982 survey, DEH defined the existing moratorium boundaries as presented on Figure 1. The purpose of the moratorium was to define the area where


CITRUS AVENUE MORATORIUM
Figure 1
N
E
S
W
Moratorium Boundary
Roads
BIG PINE
BIRCH
IDAHO
CITRUS
SAN PASQUAL VALLEY
BEAR VALLEY
BOYLE
BIRCH
2000
0
2000
4000 Feet

DEH considered that future development would intensify the current shallow groundwater problem, which could lead to an increase in septic system failures.

TABLE 1
Septic System Failures Prior to 1982

APN	Address	Water Observed	Failure Date
234-110-08	1535 Bear Valley Parkway	---	12/12/1978
234-110-07	1541 Bear Valley Parkway	---	05/11/1981
234-100-09	1546 Bear Valley Parkway	---	03/26/1973
234-110-04	1567 Bear Valley Parkway	---	11/17/1980
234-100-02	1605 Bear Valley Parkway	---	01/04/1980
234-100-05	1614 Bear Valley Parkway	---	08/08/1978
234-280-37	1678 Bear Valley Parkway	4.0 feet – 07/12/1979	07/12/1979
234-040-38	1508 S. Citrus Ave.	---	11/01/1976
234-030-09	1535 S. Citrus Ave.	4.0 feet – 09/13/1978	09/13/1978
234-030-10	1543 S. Citrus Ave.	---	12/30/1976
234-040-07	1556 S. Citrus Ave.	---	05/25/1976
234-040-12	1594 S. Citrus Ave.	---	02/02/1977
234-120-23	1653 S. Citrus Ave.	---	03/25/1976

The most impacted areas identified are along Citrus Avenue between Idaho Avenue and Big Pine Road, and along Bear Valley Parkway between Birch Avenue and Rose Avenue. In 1982 there were a total of 17 documented failures in the moratorium area and DEH issued Official Notices to 9 homeowners for failing septic systems. Table 2 provides a summary of the septic system failures observed in 1982.

As a long-term solution to failing septic systems the County Department of Public Works (DPW) began to examine the possibility of bringing in public sewer to the area. For the short-term, DEH went to the Board of Supervisors with the recommendation of establishing a moratorium on new construction in the areas that may contribute to the shallow groundwater conditions.

On June 15, 1982 the Board of Supervisors adopted the Citrus Avenue Moratorium. Included in this action was a proposal to provide DPW direction to conduct a sewer assessment for Citrus Avenue area, however the Board did not approve this portion of the proposal. Instead, the Board felt that the public should decide the issue of bringing public sewer into this area.

In 1983 and in 1987 the establishment of public sewer in the Citrus Avenue area went up for public vote. Both times the public voted against bringing public sewer into the area. As of this date no other action has been taken to bring sewer into the area.

TABLE 2
Septic System Failures in 1982

APN	Address	Water Observed	Failure Date
234-110-06	1549 Bear Valley Parkway	---	02/16/1982
234-110-05	1559 Bear Valley Parkway	---	02/16/1982
234-010-09	1460 S. Citrus Ave.	---	05/03/1982
234-010-08	1466 S. Citrus Ave.	---	05/18/1982
234-040-23	1482 S. Citrus Ave.	2.5 feet - 01/30/1981	04/28/1982
234-040-16	1498 S. Citrus Ave.	---	05/18/1982
234-040-15	1500 S. Citrus Ave.	---	05/03/1982
234-040-18	1506 S. Citrus Ave.	---	05/18/1982
234-030-07	1517 S. Citrus Ave.	---	05/18/1982
234-040-04	1524 S. Citrus Ave.	---	05/03/1982
234-030-08	1527 S. Citrus Ave.	---	05/03/1982
234-030-09	1535 S. Citrus Ave.	2.0 feet - 05/18/1982	05/18/1982
234-030-10	1543 S. Citrus Ave.	--- 2.0 feet - 06/07/1982	05/18/1982 06/07/1982
234-030-11	1549 S. Citrus Ave.	---	05/18/1982
234-040-09	1572 S. Citrus Ave.	---	05/03/1982
234-030-19	1573 S. Citrus Ave.	---	05/03/1982
234-120-24	1659 S. Citrus Ave.	---	05/04/1982

The number of developed and undeveloped parcels within the moratorium has remained roughly the same since 1982. The size of the moratorium is approximately 658 acres. Within the moratorium there are a total of 500 developed parcels consisting of approximately 394 acres, 65 vacant parcels consisting of approximately 197 acres and approximately 67 acres dedicated to road easements. Over the past 19 years a few parcels have been excluded from the moratorium. These exclusions were based on the technical demonstration that groundwater flow from the site did not drain into the basin and would not contribute to the shallow groundwater conditions.

Since the implementation of the moratorium, septic system failures have continued within the area. Table 3 is a summary of the failures that have been reported since 1982.

In November of 1998, DEH completed an extensive re-evaluation of the Valley Center Moratorium. This moratorium, like the Citrus Avenue Moratorium, was put in place due to failing septic systems as a result of shallow groundwater conditions. This moratorium was put in-place as a short-term solution with public sewer as a long-term solution. Similarly, public sewer was voted down several times resulting in no long-term solution. The Valley Center study included an evaluation of existing conditions, development to existing property configurations and development to general plan densities. This study confirmed and concluded that there was an extensive area in the valley floors where shallow groundwater conditions would not allow the use of conventional septic systems.

TABLE 3
Septic System Failures Since 1982

APN	Address	Water Observed	Failure Date
234-110-18	1525 Bear Valley Parkway	---	12/12/2000
234-110-08	1535 Bear Valley Parkway	--- 2.2 feet - 12-05-1983	06/07/1983 12/05/1983
234-110-05	1559 Bear Valley Parkway	---	09/16/1988
234-280-41	1646 Bear Valley Parkway	---	01/03/1994
234-030-25	1750 Birch Ave.	---	03/23/1983
234-030-24	1760 Birch Ave.	---	03/10/1983
234-040-23	1482 S. Citrus Ave.	---	04/29/1986
234-010-13	1428 S. Citrus Ave.	---	05/29/1984
234-010-11	1444 S. Citrus Ave.	---	03/09/1989
234-010-10	1452 S. Citrus Ave.	---	01/29/1992
234-010-09	1460 S. Citrus Ave.	---	03/10/1983
234-010-08	1466 S. Citrus Ave.	---	03/31/1983
234-040-15	1500 S. Citrus Ave.	--- ---	02/28/1993 01/11/1984
234-040-18	1506 S. Citrus Ave.	--- ---	01/31/1983 04/29/1986
234-030-08	1527 S. Citrus Ave.	--- ---	01/31/1983 03/06/1986
234-040-27	1534 S. Citrus Ave.	---	03/10/1983
234-030-09	1535 S. Citrus Ave.	--- ---	07/28/1983 04/17/2000
234-040-31	1538 S. Citrus Ave.	--- 8.0 feet - 01/05/1994	03/10/1983 01/14/1994
234-030-10	1543 S. Citrus Ave.	---	09/22/1983
234-040-06	1548 S. Citrus Ave.	--- --- ---	03/10/1983 03/25/1983 11/04/1983
234-040-07	1556 S. Citrus Ave.	---	01/27/1995
234-040-08	1564 S. Citrus Ave.	--- --- --- ---	03/10/1983 06/06/1990 07/11/1990 11/02/1990
234-030-19	1573 S. Citrus Ave.	--- ---	02/05/1986 02/17/1988
234-040-11	1586 S. Citrus Ave.	1.6 feet - 06/06/1983	06/06/1983
234-040-12	1594 S. Citrus Ave.	---	03/10/1983
234-141-01	1622 S. Citrus Ave.	---	03/05/1986
234-120-24	1659 S. Citrus Ave.	---	04/18/1991
234-141-10	1666 S. Citrus Ave.	2.0 feet - 04/08/1993	03/05/1986
234-120-26	1669 S. Citrus Ave.	---	05/03/2000
234-120-27	1681 S. Citrus Ave.	--- 3.0 feet - 02/24/1988	03/25/1985 02/24/1988
234-240-38	1807 S. Citrus Ave.	13.0 feet - 09/01/1998	09/01/1998

Further, the study determined that due to the basin's configuration, geology and hydrogeologic conditions, development on the higher elevation lands had limited effect on the rise in water levels in the valley floor. As an alternative to public sewer the use of on-site mound systems were approved in those areas with shallow groundwater conditions.

Starting in November of 2000, staff of the Department of Environmental Health (DEH) began a re-evaluation of the Citrus Avenue Moratorium. This evaluation included a review of: the underlying facts that were used in initiating the moratorium in the early 1980's; historical land uses; development; rainfall; soils; geology; hydrogeology; and surface water hydrology. This evaluation was completed to determine alternatives, if any, for the Department regarding the continuation, modification or removal of the moratorium that was established in 1982. The following evaluation expanded the study area to include all the lands that drain into the Citrus Avenue and Bear Valley Parkway drainages to San Pasqual Road. Figure 2 provides the boundaries of the Citrus Avenue watershed.

2.2 Watershed Evaluation

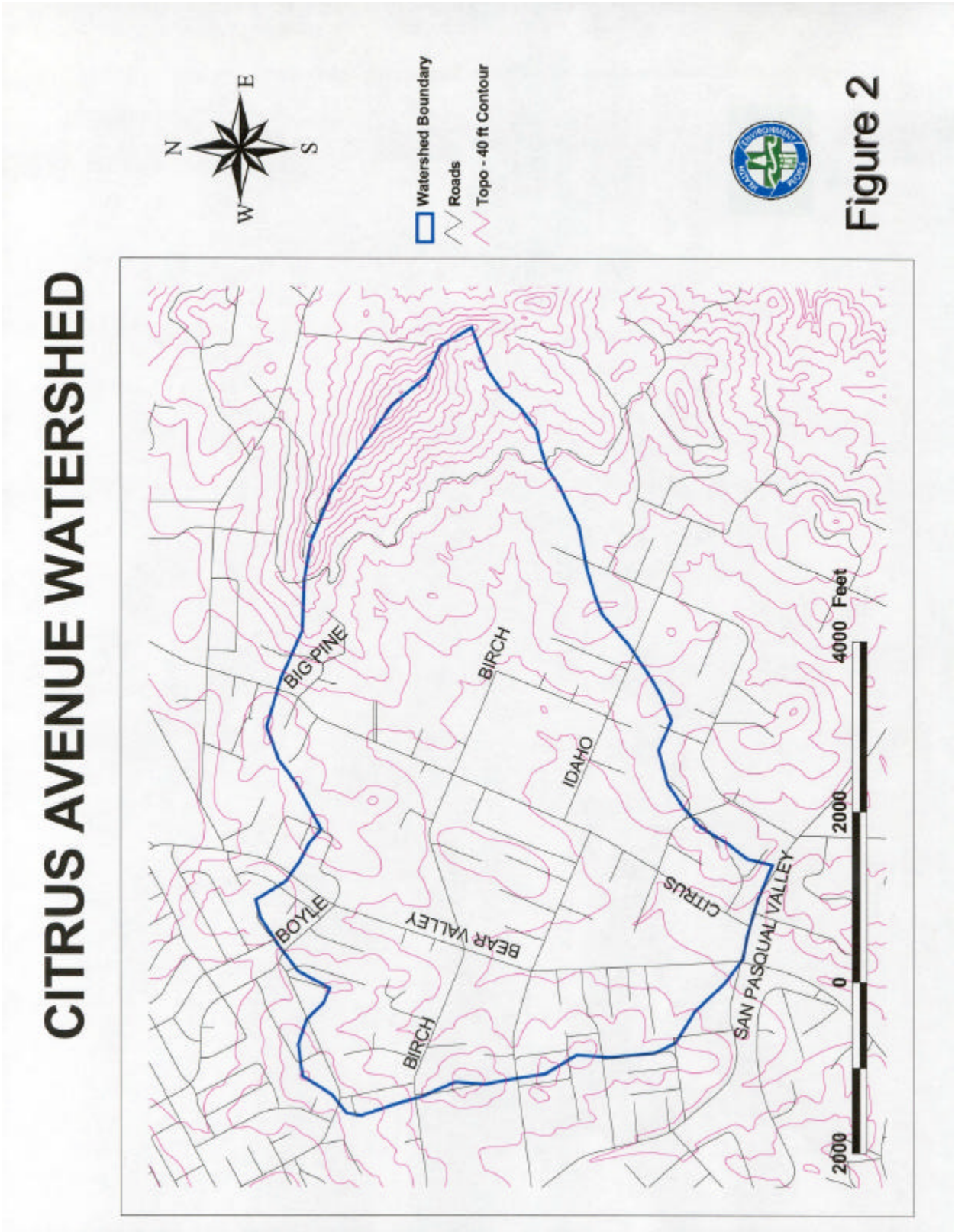
Today, there are a total of 565 parcels located within the Citrus Avenue Moratorium boundaries. Thirty-seven (37) of these parcels are partially within the moratorium. The moratorium consists of approximately 658 acres.

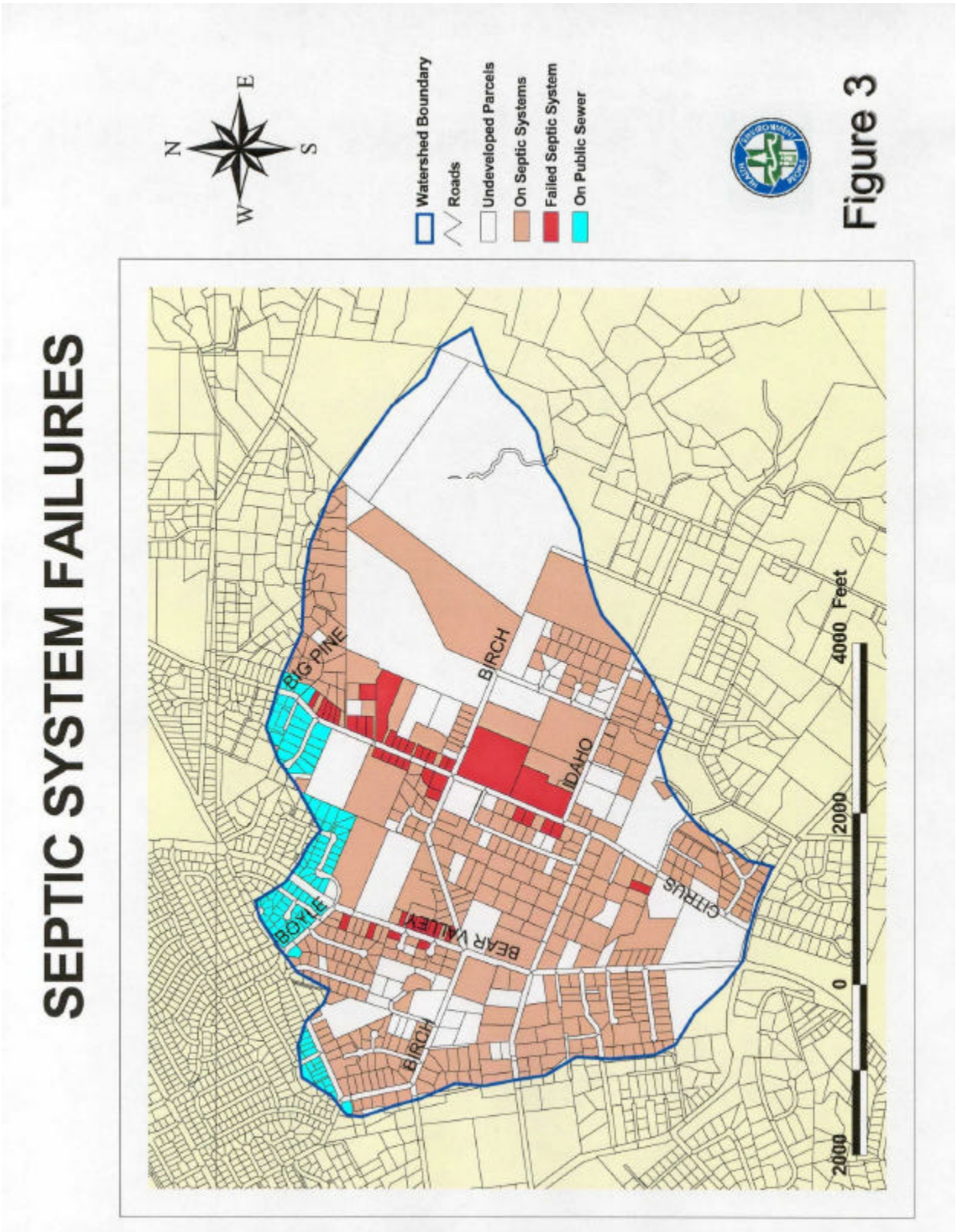
To properly evaluate the potential impacts to the hydrologic basin it was necessary to include all lands that drain into the Citrus Avenue watershed. The Citrus Avenue watershed consists of approximately 756 acres. Figure 2 provides the boundaries of the Citrus Avenue watershed.

A review of topographic maps and parcels maps of the area has demonstrated that there are a total of 662 parcels located in the Citrus Avenue watershed. One hundred and two (102) of these parcels are partially within the watershed.

A more detailed review of these maps, aerial photos and field evaluation identified there are 590 developed parcels and 72 undeveloped parcels. This represents a total of 407 acres being developed, 281 acres being undeveloped and 68 acres reserved for road easements.

Figure 3 provides the general location of the properties that have experienced septic system failures. In addition, Figure 3 provides the locations of properties within the watershed that currently are on septic systems, public sewer and that are currently undeveloped.


CITRUS AVENUE WATERSHED
Figure 2
N
E
S
W
Watershed Boundary
Roads
Topo - 40 ft Contour
BIG PINE
BIRCH
IDAHO
BOYLE
BEAR VALLEY
CITRUS
SAN PASQUAL VALLEY
BIRCH
2000
0
2000
4000 Feet


SEPTIC SYSTEM FAILURES
Figure 3
N
E
S
W
Watershed Boundary
Roads
Undeveloped Parcels
On Septic Systems
Failed Septic System
On Public Sewer
BIG PINE
BIRCH
IDAHO
BOYLE
BEAR VALLEY
CITRUS
BIRCH
2000
0
2000
4000 Feet

Agricultural uses occur on both developed lands and undeveloped lands within the watershed. Based on this review, it has been estimated that there are 49 developed parcels that continue to be used for citrus and/or avocado groves. These parcels cover an area of approximately 106 acres. Of the undeveloped parcels there are a total of 19 parcels being used for citrus and/or avocado groves covering an area of approximately 211 acres. There are a total of 7 developed parcels and 6 undeveloped parcels that are used for some form of field crops (primarily dry farmed). These dry farming activities cover a total area of approximately 73 acres.

To understand the groundwater and surface water dynamics of the Citrus Avenue watershed, a review of the watershed's hydrologic conditions was completed. This evaluation included a detailed review of the watershed's geology, surface hydrology and groundwater hydrology. The evaluation was also complemented by several field visits to the area to verify site conditions.

3. GEOLOGY AND SOILS

The study area is located within a portion of San Diego County that is underlain by crystalline bedrock. This crystalline bedrock is a part of the Peninsular Ranges batholith that is Cretaceous in age. These crystalline rocks have been described as the Green Valley Tonalite in this area (California Division of Mines and Geology, 1963). A review of a limited number of outcrops and a review of well logs for this area confirm these conditions.

Due to surface weathering in the study area, outcrops of the granitic rocks are limited to the higher elevation within the watershed. Overlying the crystalline bedrock is in-situ weathered bedrock (decomposed granite). Commonly in San Diego County, decomposed granite can range from 0 to greater than 100 feet in thickness. Based on a review of well logs and field observation, the thickness of decomposed granite ranges from 0 to approximately 56 feet.

Overlying the decomposed granite is 0 to 74 inches of sandy topsoil. Table 4 summarizes the general soil properties and Figure 4 shows the distribution of the surface soils as described in the U.S. Department of Agricultural Soil Survey (1973).

The surface drainage patterns and general topography of the area demonstrate the typical regional structural patterns that are characteristic of the Peninsular Ranges batholith in San Diego County. Regional fracturing in the bedrock generally follows a north-northwest to the south-southeast trend with a lesser dominant fracture pattern of northeast to southwest.

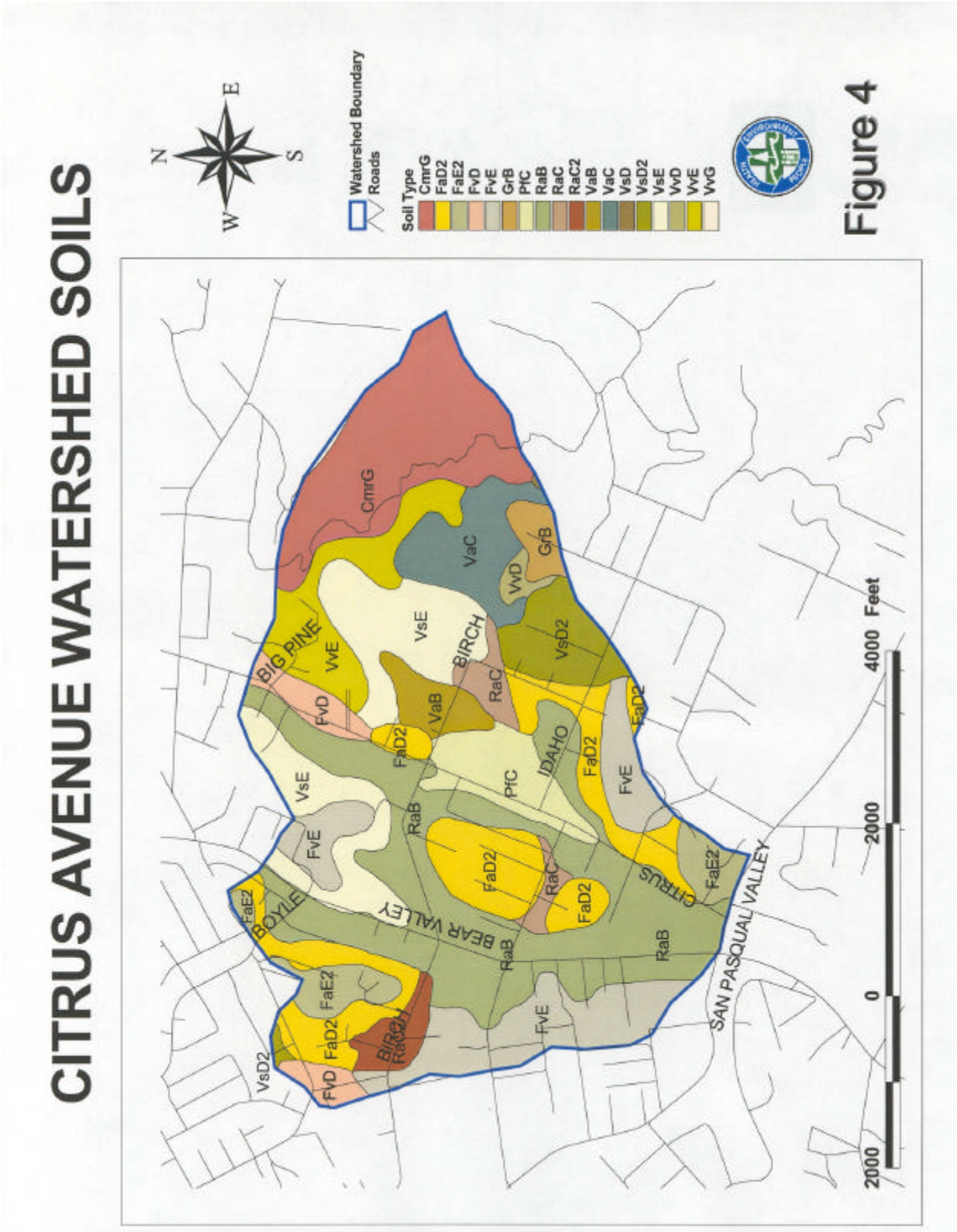

CITRUS AVENUE WATERSHED SOILS
N
E
S
W
Watershed Boundary
Roads
Soil Type
CmrG
FaD2
FaE2
FvD
FvE
GrB
PfC
RaB
RaC
RaC2
VaB
VaC
VsD
VsD2
VsE
VvD
VvE
VvG
Figure 4
BIG PINE
BIRCH
IDAHO
BOYLE
BEAR VALLEY
CITRUS
SAN PASQUAL VALLEY
2000
0
2000
4000 Feet

TABLE 4
Surface Soil Classification

	NAME	Slope (%)	Runoff	Soil Moisture Capacity (inches)	Rooting Depth (inches
CmE2	Cieneba rocky coarse loam	9 - 30	Rapid to Very Rapid	1.0 – 1.5	15
CmrG	Cieneba rocky coarse loam	30 - 75	Rapid to Very Rapid	1.0 – 1.5	15
CnE2	Cieneba-Fallbrook rocky sandy loam	9 - 30	Medium to Rapid	1.0 – 5.0	20 – 34
GrB	Greenfield sandy loam	2 - 5	Slow	5.5 – 7.5	60
FaD2	Fallbrook sandy loam	9 – 15	Slow to Medium	4.5 - 7.5	28 - 60
FaE2	Fallbrook sandy loam	15 -30	Medium to Rapid	4.5 - 6.0	28 - 60
FvD	Fallbrook-Vista sandy loam	9 - 15	Medium	4.0 - 7.5	30 - 57
FvE	Fallbrook-Vista sandy loam	15 - 30	Medium to Rapid	3.5 - 6.0	20 - 50
PfC	Placentia sandy loam	2 –9	Slow to Medium	4.0 - 5.0	20 - 36
RaB	Ramona sandy loam	2 - 5	Slow to Medium	8.5 - 10.5	+ 60
RaC	Ramona sandy loam	5 - 9	Slow to Medium	8.5 - 10.5	+ 60
RaC2	Ramona sandy loam	5 – 9	Slow to Medium	8.5 - 10.5	+ 60
VaB	Visalia sandy loam	2 - 5	Slow	8.0 - 9.5	+ 60
VaC	Visalia sandy loam	5 - 9	Slow to Medium	8.0 - 9.5	+ 60
VsD	Vista coarse sandy loam	9 - 15	Medium	4.0 - 6.0	27 - 47
VsD2	Vista coarse sandy loam	9 – 15	Medium	3.5 - 5.5	27 - 47
VsE	Vista coarse sandy loam	15 – 30	Medium to Rapid	3.5 - 5.5	20 -42
VvD	Vista rocky coarse sandy loam	5 - 15	Medium	2.0 – 4.5	20 -36
VvE	Vista rocky coarse sandy loam	15 - 30	Medium to Rapid	2.0 – 4.5	20 -34
VvG	Vista rocky coarse sandy loam	30 - 65	Rapid to Very Rapid	2.0 – 4.0	20 - 32

4. SURFACE HYDROLOGY

The area has two main surface drainages that combine near the intersection of Sunny Slope Drive and Citrus Avenue. The western sub-drainage encompasses the area that surrounds Bear Valley Parkway whereas the eastern sub-drainage encompasses the area around Citrus Avenue and the eastern extent of Birch Avenue.

4.1 Bear Valley Parkway Sub-Drainage

The creek in the Bear Valley Parkway sub-drainage is an ephemeral stream that flows generally in the winter months. This creek primarily consists of a shallow drainage swale. North of Birch Avenue the drainage is incorporated into an unlined road ditch along Bear Valley Parkway.

Based on 1968 U.S. Geological Survey topographic maps prior to development along Bear Valley Parkway, the natural drainage swale north of Birch Avenue was located in the rear yards and front yards of the residences between 1510 and 1678 Bear Valley Parkway. From site reconnaissance and further review of DEH records indicates that a

number of the current septic systems are most likely located in the area of this historic swale.

The improved surface drainage along Bear Valley Parkway in general appears to have a limited capacity and it is expected that during higher than normal rainfall years there could be flooding of the residences on the eastern side of Bear Valley Parkway north of Birch Avenue. This flooding is likely to aggravate the shallow groundwater conditions in this area.

4.2 Citrus Avenue Sub-Drainage

The creek located in the Citrus Avenue sub-drainage flows year round primarily due to agricultural activities in the eastern part of the sub-drainage area. This creek flows from the eastern end of Birch Avenue and then crosses Citrus Avenue between Idaho Avenue and Sunny Brook Drive. Where the creek crosses Citrus Avenue, a subsidiary drainage swale combines with the creek. This swale drains the northern portion of Citrus Avenue. This subsidiary drainage has water flowing in it seasonally.

A review of the 1968 U.S. Geological Survey topographic maps of the Citrus Avenue area indicated the historic swale was along Citrus Avenue in a road ditch.

5. GROUNDWATER RECHARGE

Groundwater Recharge within the Citrus Avenue watershed occurs from precipitation infiltration, septic system infiltration and irrigation return flows. In this area, the irrigation return flow includes contributions from residential landscaping as well as agricultural activities.

Groundwater recharge occurs primarily by the infiltration of water through the surface soils into the underlying decomposed and fractured crystalline granitic rocks. In isolated cases where the crystalline rocks are exposed at the surface, recharge directly into the fractures may occur.

5.1 Rainfall infiltration / recharge

Groundwater recharge from precipitation was estimated using the soil moisture budget approach. This method compares rainfall, runoff and potential evapotransperation on a monthly basis to calculate potential recharge. The following equation was used to calculate recharge from precipitation:

$R_i = P_i - Ro_i - PET_i - (SM_i - SMC)$

Where: R_i = Monthly calculated recharge
P_i = Monthly precipitation
Ro_i = Monthly runoff
PET_i = Monthly potential evaptransperation
SM_i = Soil moisture content at end of the month
SMC = Soil moisture capacity of the soil

To use this method the basic input parameters need to be evaluated.

5.1.1 Precipitation

To estimate the contribution of natural rainfall to groundwater recharge, the Escondido rainfall station located in downtown Escondido was used. Figure 5 provides a complete annual summary of the Escondido Rainfall record. This record has been collected from 1897 to present. Even though the weather station was relocated in 1982, the two sites are considered to provide equivalent rainfall data. For the purpose of this study, these two stations' data was combined and is considered to be one rainfall station. There were several years where the rainfall data was incomplete so data from the Lake Hodges rainfall station was used to complete the missing record. Based on the 103-year rainfall record, the average annual rainfall for Escondido is 15.48 inches.

5.1.2 Runoff

Accurate information on runoff for a given rainfall event is not available for this area of San Diego County. In general, runoff is highly dependent on a number of variables such as: rainfall intensity, soil type, slope, land use, and when the rainfall event occurs in the season.

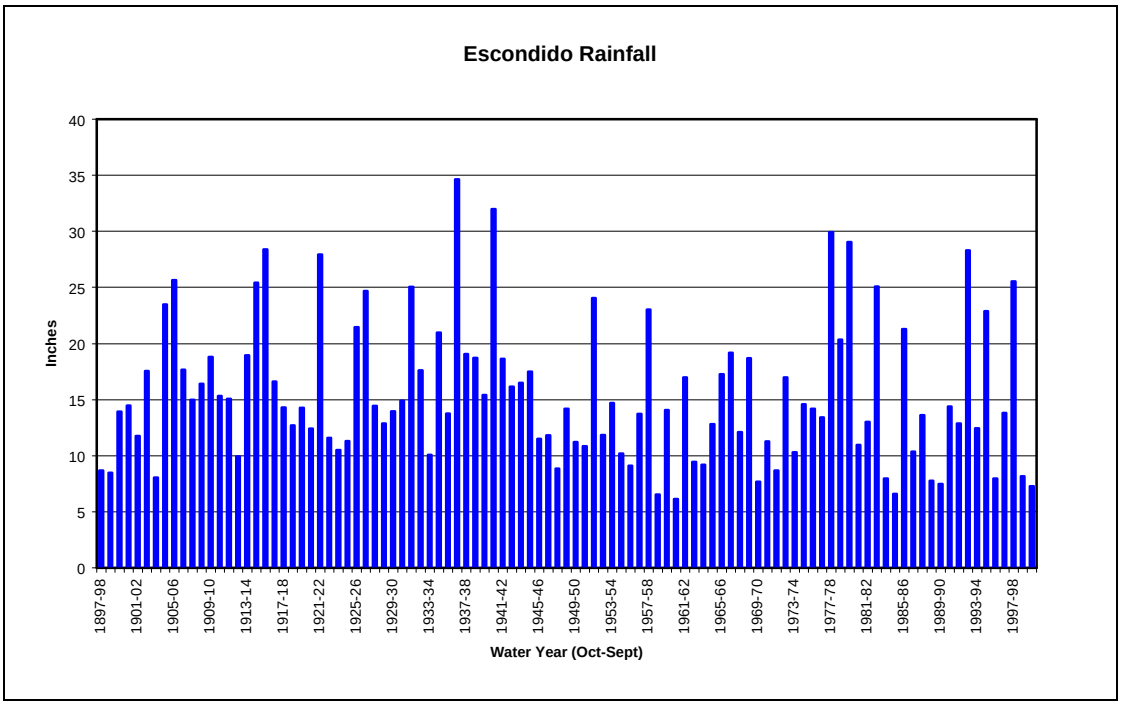
Huntley (1990) presented the methodology, outlined below, that is considered appropriate to evaluate runoff in San Diego County when runoff data is not available. This method tries to deal with the dependence of runoff on both the rainfall rate and on antecedent soil moisture. This is accomplished by using the following equation:

$Ro_i – Ro_{max} * (SM_i / SMC)$

Where: Ro_i = Monthly runoff
Ro_{max} = Maximum percent runoff
SM_i = Soil moisture content at end of the month
SMC = Soil moisture capacity of the soil

This equation is used to iteratively calculate the runoff for each month as a function of the average moisture content for that month.

FIGURE 5



After a review of the mapped soil types in the area, four categories of runoff potential were identified based on slope. Table 5 summarizes the estimated runoff factors as a percentage of the monthly rainfall used in this analysis. Comparison of these estimates to other areas of San Diego County indicates that these are reasonable estimates for this area.

TABLE 5
Runoff Factors

Slope (%)	**0 – 9**	**9-15**	**15-30**	**30-75**
Average Runoff	2%	4%	8%	16%

5.1.3 Potential Evapotranspiration

Throughout San Diego County, evaporation potential is measured to manage the various surface water reservoirs and agricultural activities. Evaporation potential is monitored using an evaporation pan. These stations provide site-specific measurements on seasonal potential evaporation rates. The three nearest stations are

Lake Hodges, San Pasqual and Lake Wolford. After a review of the location of these stations, it was concluded that the San Pasqual station records were representative for the study area. The San Pasqual record represents data collected from 1946 to 1954. Evaporation was measured using a standard Class A evaporation pan. The data was corrected using a 0.70 pan correction coefficient. Table 6 provides a summary of the San Pasqual corrected evaporation data.

TABLE 6
Potential Evapotranspiration

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
San Pasqual [1]	3.79	2.78	1.88	2.18	1.93	3.57	3.73	5.03	5.76	6.80	6.54	5.54

[1] Climates of San Diego County, Agricultural Relationships, University of California Agricultural Extension Services, 1970, page 88.

5.1.4 Soil Moisture Capacities

The range of soil moisture capacities for the various soils in the area is provided in Table 4. Since this evaluation did not include subsurface investigations to verify soil types, soil properties and rooting depth, a field reconnaissance was completed to evaluate the watershed's soil conditions and soil structure. This was accomplished by examining road cuts and outcrops within the study area. Based on this limited field evaluation, it was concluded that it was reasonable to use 60% of the soil moisture capacity range.

5.1.5 Estimate of Groundwater Recharge

Using the information outlined above, groundwater recharge from rainfall was calculated. Table 7 summarizes the annual recharge for the Citrus Avenue moratorium over the entire Escondido rainfall record.

5.2 Residential infiltration / recharge

To understand how much groundwater recharge can occur from residential uses it is necessary to know how much water is used in the typical household and for landscape irrigation. Within this area of the county, potable water is imported and groundwater uses are limited.

A detailed evaluation of existing development within the study area identified a total of 473 residences on septic systems and 117 residences on public sewer. On-site sewage disposal systems and landscape irrigation are the primary sources of water for groundwater recharge related to residential uses.

TABLE 7
Estimated Groundwater Recharge from Rainfall

	Name	Area (acres)	Soil Moisture Capacity (inches)	Recharge Rate (ac-ft/ac/yr)	Average Recharge (ac-ft/yr)
CmrG	Cieneba rocky coarse loam	89.4	1.3	0.126	11.26
FaD2	Fallbrook sandy loam	98.4	6.3	0.078	7.68
FaE2	Fallbrook sandy loam	26.7	5.4	0.062	1.66
FvD	Fallbrook-Vista sandy loam	19.9	6.1	0.082	1.63
FvE	Fallbrook-Vista sandy loam	81.3	5.0	0.071	5.77
GrB	Greenfield sandy loam	9.6	6.7	0.087	0.84
PfC	Placentia sandy loam	30.2	4.6	0.143	4.32
RaB	Ramona sandy loam	168.1	9.7	0.042	7.06
RaC	Ramona sandy loam	14.7	9.7	0.042	0.62
RaC2	Ramona sandy loam	12.5	9.7	0.042	0.53
VaB	Visalia sandy loam	14.9	8.9	0.050	0.75
VaC	Visalia sandy loam	34	8.9	0.050	1.70
VsD	Vista coarse sandy loam	0.2	5.2	0.105	0.02
VsD2	Vista coarse sandy loam	28.3	4.7	0.119	3.37
VsE	Vista coarse sandy loam	82.2	4.7	0.079	6.49
VvD	Vista rocky coarse sandy loam	4.4	3.5	0.162	0.71
VvE	Vista rocky coarse sandy loam	40.2	3.5	0.118	4.74
VvG	Vista rocky coarse sandy loam	1	3.2	0.047	0.05
	TOTALS	**756.0**			**59.19**

To determine the amount of recharge that can occur from typical residential uses, water usage information was reviewed. Limited water usage figures were provided by the City of Escondido to assist in this evaluation. This data consisted of water usage for four residential properties. Figure 6 summarizes the data.

The residential water use figures included both old and new residences in the area. Based on this review, a typical residential property averages approximately 500 gallons per day.

Huntley (1979) completed a more detailed analysis of water use within the Padre Water District. This study included areas of Alpine, El Cajon and Lakeside. His analysis showed an average water use of 552 gallons per day. Table 8 summarizes the monthly average water use from our analysis of the Citrus Avenue data and from Huntley (1979).

FIGURE 6

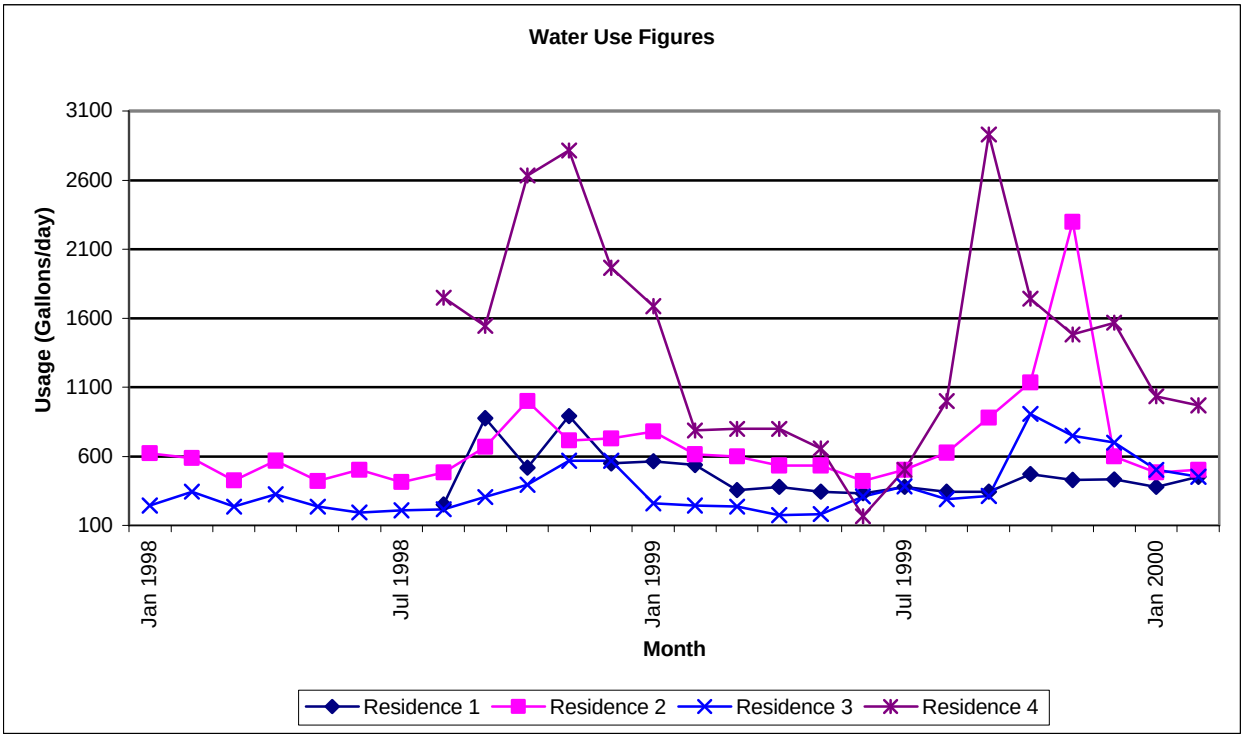


TABLE 8
Average Residential Water Use Figures (gal/day)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Citrus Ave	466	363	404	340	351	365	368	563	737	941	596	472
Padre Dam WD	721	685	434	298	245	234	258	397	642	752	876	1090

Since the data from Padre Dam Water District was based on a much larger sample population, those water use figures were considered more reliable and were used in our analysis. It is generally accepted that 240 gallons per day of the water is used inside the residence and eventually is discharged in the sewer or septic system. This pattern of water use is reflected well in the monthly usage figures for the months of January through April. During the summer months usage is much greater reflecting the need for watering and irrigation outside the residence. The remaining water is used for outside landscaping and other uses. Using the Padre Dam data it is estimated that on the average approximately 312 gallons per day is used for landscape irrigation.

Based on the water use values listed above, it is assumed all water disposed in the on-site septic system will eventually recharge groundwater and approximately 10% of the water applied for irrigation will recharge groundwater. With these assumptions, the

estimate of the groundwater recharge for the current residential uses in the watershed is shown in Table 9.

TABLE 9
Estimated Groundwater Recharge from Residential Uses

Use	Area (acres)	# of Parcels	Recharge (ac-ft/yr.)
Residential (Septic)	379	473	127.2
Residential (Sewer)	31	117	0.0
Residential (Landscape)	410	590	21.1
TOTAL RESIDENTIAL RECHARGE:			**148.2**

5.3 Agricultural return flow / recharge

The Citrus Avenue area has historically been an active area agriculturally. Irrigation of the agricultural land within the watershed utilizes a significant amount of water. To evaluate on the historical and current agricultural activities, historical aerial photos were reviewed and field verification was completed.

A review of County and U.S. Geological Survey aerial photos from 1970, 1978 and 1996 indicate the land uses in the area have generally remained the same. Of the 390 acres of land that has been identified as having agricultural activities currently there are approximately 217 acres of irrigated citrus groves, avocado groves and grapes within the watershed.

Since actual water use figures for the agricultural activities within the watershed were not available, we have used published consumptive use figures for avocados and citrus trees provided by the U.S. Department of Agricultural (USDA Soil Survey, 1973). The consumptive uses of avocado trees are approximately 3.5 acre-feet per acre per year and for citrus trees are 3.0 acre-feet per acre per year. A consumptive use figure for vineyard grapes has been estimated to be approximately 1.4 acre-feet per acre per year based on a U.C. Davis study in the Temecula area (Bender, 2001, Personal communication).

It is a general practice for grove operators to over-irrigate occasionally to leach out salts that build-up in the rooting zone. For the purpose of this evaluation the consumptive use figures were increased by 20% to compensate for this over-irrigation. In general, the irrigation return flow from the agricultural activities is represented by the 20% over-irrigation with the remaining water being used by the trees.

The agricultural activities are located throughout the watershed with the most intense activities being located on the eastern side of Citrus Avenue sub-drainage. Table 10

provides an estimate of the annual-average consumptive use figures for the various crops cultivated in this area.

TABLE 10
Estimated Groundwater Recharge from Agricultural Return Flow

Crop	Consumptive Use (ac-ft/ac/yr)	Application Rate (ac-ft/ac/yr)	Irrigation Return Flow (ac-ft/ac/yr)	Coverage (ac)	Annual Application (ac-ft)
Avocados	3.5	4.20	0.70	46	32.2
Citrus	3.0	3.60	0.60	166	99.6
Grapes	1.4	1.68	0.28	5	1.4
			TOTALS:	**217**	**133.2**

6. GROUNDWATER STORAGE

Groundwater in transit though a saturated aquifer is defined as groundwater in storage. The quantity of water in storage will vary from year to year depending on annual groundwater recharge and discharges from the watershed. Recharge to the groundwater system depends on recharge from precipitation, stream flow and groundwater flow into the watershed, irrigation return water and on-site sewage disposal systems. Additionally, discharges from the watershed can occur by stream flow and groundwater flow out of the watershed, evapotranspiration from vegetation and well production within the watershed. Based on the basin's configuration, stream flow and groundwater flow into the watershed does not occur. The other recharge components are outlined in the preceding section. The discharge mechanisms of stream flow and groundwater flow out of the watershed, evapotranspiration from vegetation and well production all occur in the watershed. At this time it is not possible to quantify the discharge mechanisms due to the lack of monitoring data.

Due to the lack of detailed study and groundwater monitoring data within the Citrus Avenue watershed, the amount of water in storage cannot be determined. However, in general, the two groundwater aquifers in the area are the fractured crystalline rock aquifer and the decomposed granite aquifer.

Statistical studies in San Diego County by Lough and Lower (1976), Lower (1977) and Olsen (1978) have all indicated that the groundwater table and the interface between the decomposed granite and the crystalline bedrock follow a subdued profile of the surface topography. Based on the limited data it is believed that this is true for the Citrus Avenue watershed.

It has generally been recognized that the non-vertical fractures in crystalline rock aquifer has an effective depth or approximately 400 feet. Below this depth the fractures generally become too tightly closed to accommodate appreciable amounts of water. In contrast the vertical and near vertical factures systems can extend to significant depths. In general, in San Diego County the practical depth is on the order of 1,000 feet based on the economics of installation of production wells.

The effective porosity (specific yield) of this aquifer is considered to decrease with depth. Porosity can range from as high as 4 percent near the ground surface to low as 0.0001 percent at depth it has been generally assumed that the effective porosity for a 1,000 thickness is approximately 0.1 percent.

The decomposed granite aquifer has been evaluated in other areas of the county by Lough and Lower (1976), Lower (1977) and Olsen (1978). Typically the specific yield of these materials will range from 3 to 10 percent.

Even though there is no site specific data related to the amount of water in storage or the storage capacity of the watershed, there is reasonable information to infer the relative conditions of the groundwater in storage.

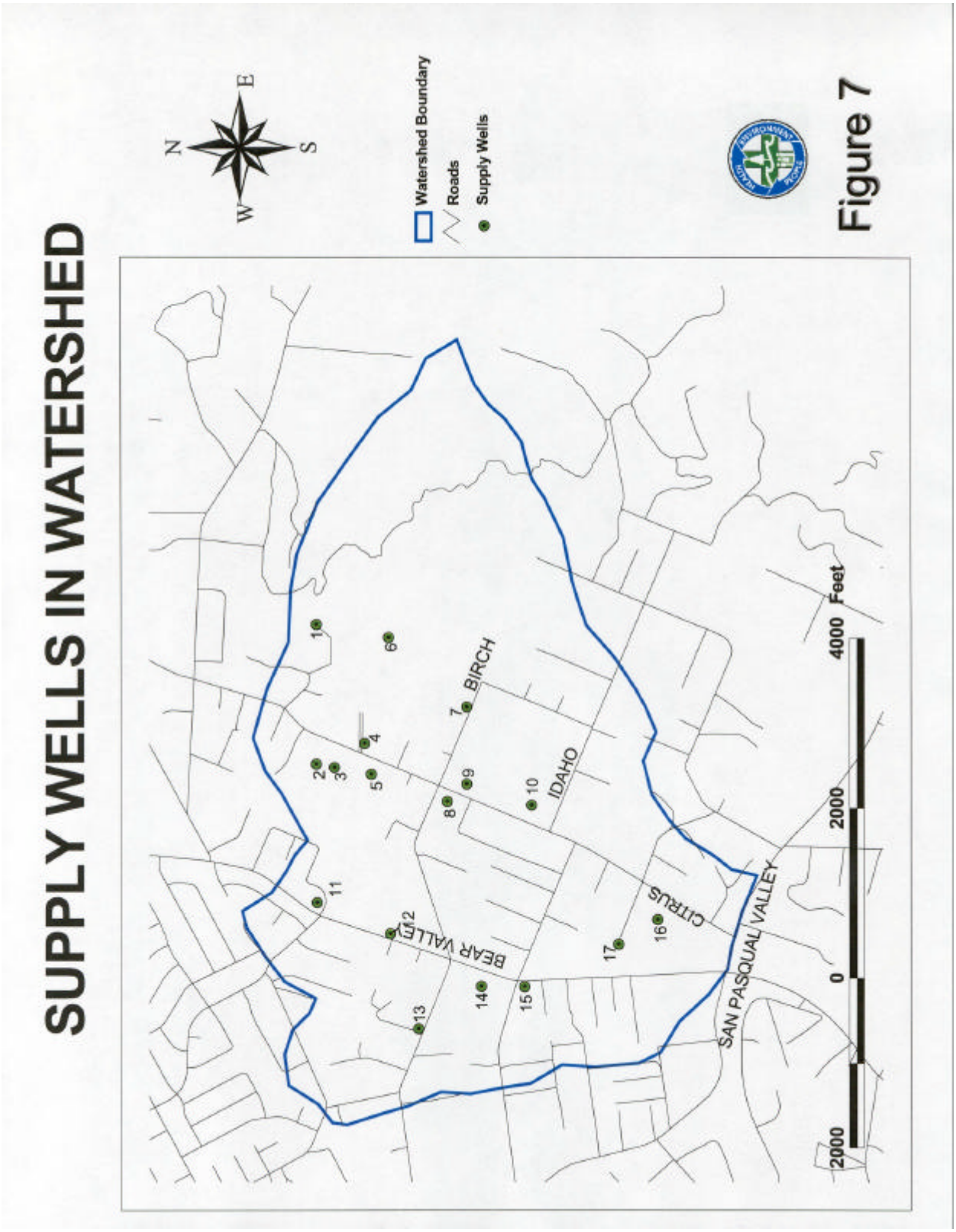
Since the 1950s, this area has been receiving imported water for both domestic and agricultural uses. As a result, this area's use of groundwater has significantly diminished. An evaluation of the watershed has identified a total of 17 supply wells. Table 11 summarizes the status of each of these wells, with Figure 7 providing their approximate locations. Based on our evaluation, currently there are 7 wells being used within the watershed. These wells are primarily being used of agricultural or landscaping uses. There is also a public supply well owned by the City of Escondido that is currently inactive.

Based on the rainfall data, the septic system failure history of the area (Figure 8) and field observation by DEH since the early 1970s, the other recharge elements within the basin within the watershed are significant enough to maintain the shallow groundwater levels.

Since shallow groundwater conditions have been present seasonally since the early 1970s, it can be concluded the groundwater system is nearly full in terms of its groundwater storage capacity.

TABLE 11
Supply Wells Located in Watershed

Well No.	APN	Owner	Address	Status
1	234-010-88	Robert & Amelia Delreal	2450 Crestview Estates Pl, Esc.	Active - Domestic
2	234-030-05	Lorene A. Bosch, Tr	S Citrus Ave, Esc.	Inactive
3	234-030-05	Lorene A. Bosch, Tr	S Citrus Ave, Esc.	Inactive
4	234-040-38	Tracy Gelvin	1508 S Citrus Ave, Esc.	Inactive
5	234-030-06	Tamela R. Ridley	1509 S Citrus Ave, Esc.	Inactive
6	234-040-36	Edward Lyon	Birch Ave, Esc.	Active - Irrigation
7	234-040-36	Edward Lyon	Birch Ave, Esc.	Active - Irrigation
8	234-120-43	Vincent & Rafaela Ruiz	Birch Ave, Esc.	Active - Irrigation
9	234-141-01	Hawthorne Country Store, Inc.	1622 S Citrus Ave, Esc.	Inactive
10	234-141-10	Brain & Jacqueline Hawthorne	1666 S Citrus Ave, Esc.	Active - Irrigation
11	234-030-31	Westminster Theolgical Seminar	1725 Bear Valley Pky, Esc.	Active - Irrigation
12	234-110-03	Brian Goddard	Bear Valley Pky, Esc.	Inactive
13	234-080-18	Ralph & Dorothy Ceci	Birch Ave & Birch Way, Esc.	Inactive
14	234-220-29	John L. Mundorff, Tr	1332 Bear Valley Pky, Esc.	Inactive
15	234-231-09	William & Wendy Snapp	Idaho Ave, Esc.	Active - Irrigation
16	234-240-05	City of Escondido	S Citrus Ave, Esc.	Inactive
17	234-240-44	Homer & Betty Chaffin, Tr.	1821 S Citrus Ave, Esc.	Unknown


SUPPLY WELLS IN WATERSHED
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Roads
Supply Wells
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IDAHO
BEAR VALLEY
CITRUS
SAN PASQUAL VALLEY
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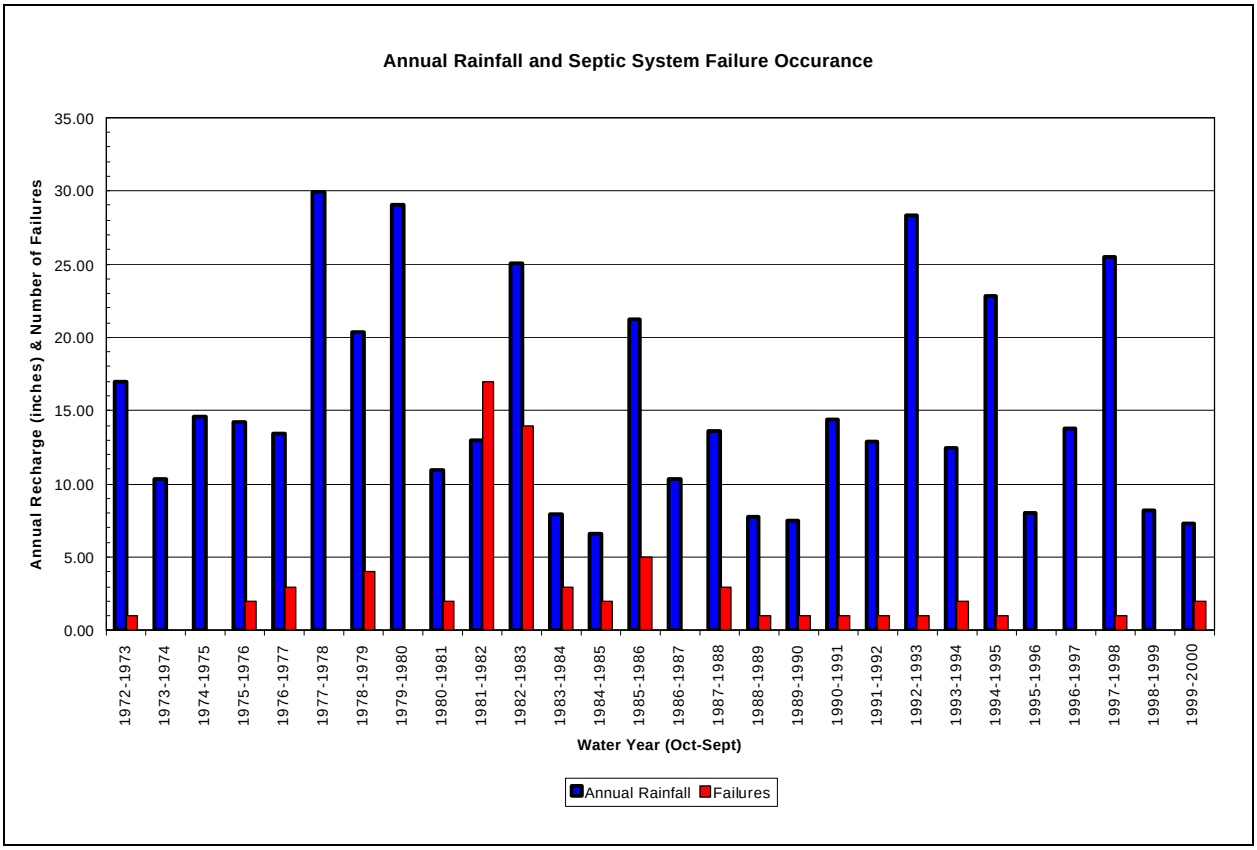
Figure 7

FIGURE 8



7. WATERSHED DEVELOPMENT

For the purpose of this study, three development scenarios were evaluated. The scenarios are:

Scenario 1 - Current Development with no change,
Scenario 2 - Build-out of existing parcels with one residence and
Scenario 3 - The maximum probable build-out of the watershed

Scenario 1 has been evaluated in the preceding section. For both scenarios 2 and 3, we have assumed that each lot can meet the current septic system groundwater separation and design criteria. Using this assumption is considered to be a worst-case condition to evaluate groundwater impacts. For scenario 3 the smallest subdivision of land was assumed to be one acre. Even though some of the areas within the watershed have been zoned for parcels as small as 0.23 acres, the one-acre minimum

size is considered more realistic due to the general limitation of siting a septic system in this area.

For the evaluation under Scenario 2 we have assumed that the current undeveloped parcels will be developed with a single-family residence. This change in use is expected to have no significant changes in the agricultural activities within the watershed. This would result in an increase of number of developed parcels from 590 to a total of 662 within the watershed.

For the evaluation under Scenario 3, the agricultural activities would be significantly reduced. It is recognized that individual property owners will continue to maintain a portion of these agricultural activities. Based on this change in use, the agricultural recharge was reduced by 50 percent of the current estimate. Development of the watershed to its maximum probable build-out would likely result in an addition of 311 parcels. The total number of developed parcels under Scenario 3 would be 901.

Table 12 provides a summary of the groundwater recharge for Scenario 1, Scenario 2 and Scenario 3.

TABLE 12
Groundwater Recharge and Watershed Development Scenarios

SCENARIO 1 -- CURRENT DEVELOPMENT				
	Type of Recharge		**Recharge**	**Percent**
	Natural Groundwater Recharge	756 acres	59.2 ac-ft/yr	17%
	Septic Systems	473 residences	127.2 ac-ft/yr	37%
	Residential Irrigation	590 residences	21.1 ac-ft/yr	6%
	Agricultural Irrigation	217 acres	133.2 ac-ft/yr	39%
		TOTAL RECHARGE:	**340.6 ac-ft/yr**	100%
SCENARIO 2 -- BUILD-OUT OF EXISTING PARCELS				
	Type of Recharge		**Recharge**	**Percent**
	Natural Groundwater Recharge	756 acres	59.2 ac-ft/yr	16%
	Septic Systems	544 residences	146.2 ac-ft/yr	40%
	Residential Irrigation	661 residences	23.6 ac-ft/yr	7%
	Agricultural Irrigation	217 acres	133.2 ac-ft/yr	37%
		TOTAL RECHARGE:	**362.3 ac-ft/yr**	100%
SCENARIO 3 -- MAXIMUM PROBABLE BUILD-OUT WITH SEPTIC SYSTEMS				
	Type of Recharge		**Recharge**	**Percent**
	Natural Groundwater Recharge	756 acres	59.2 ac-ft/yr	16%
	Septic Systems	784 residences	210.8 ac-ft/yr	57%
	Residential Irrigation	901 residences	32.2 ac-ft/yr	9%
	Agricultural Irrigation	108.5 acres	66.6 ac-ft/yr	18%
		TOTAL RECHARGE:	**368.7 ac-ft/yr**	100%

8. DISCUSSION

In general, the study area has had a documented history of septic system failures since the early 1970s. These failures have been attributed primarily to shallow groundwater conditions. The failures are found primarily along the road alignments for Bear Valley Parkway and Citrus Avenue. After evaluating the area's rainfall, geology, soils and surface topography, it has been concluded that the septic systems located on Bear Valley Parkway between Birch Avenue and the northern watershed boundary and the septic systems located on Citrus Avenue between Idaho Avenue and the northern watershed boundary would not meet the current septic system siting criteria for groundwater separation.

Along the eastern side of Bear Valley Parkway north of Birch Avenue, a number the septic systems were constructed in the old natural drainage swale. The improved surface drainage that exists today is now along the road alignment of Bear Valley Parkway. This improvement generally consists of an unlined road ditch and in areas it has a limited capacity. As a result, there is a greater likelihood of in flooding. Such flooding would negatively impact the shallow groundwater conditions in the area.

Citrus Avenue, north of Idaho Street, was built in the old drainage swale. The residences on both sides of the road have experienced numerous system failures. These failures appear to be attributed to their proximity to the historic swale. Similar to Bear Valley Parkway, the improved surface drainage is now an unlined road ditch. Even though flooding does not appear to be a problem, excessive infiltration of runoff could aggravate the shallow groundwater conditions along the road alignment.

Following the high rainfall years in the late 1970s, DEH changed the septic system siting criteria countywide. This change requires the demonstration of groundwater separation with possible groundwater monitoring of the site or area thorough a normal rainfall year when shallow groundwater conditions are suspected or are observed. Based on this evaluation, the residences that are located along both Bear Valley Parkway and Citrus Avenue would not meet these requirements. It should be noted that these properties were developed prior the implementation of these requirements.

In general, the existing septic systems that are constructed at distances greater than 150 feet from the historic and existing improved drainage structures within the watershed generally do not have a significant failure record.

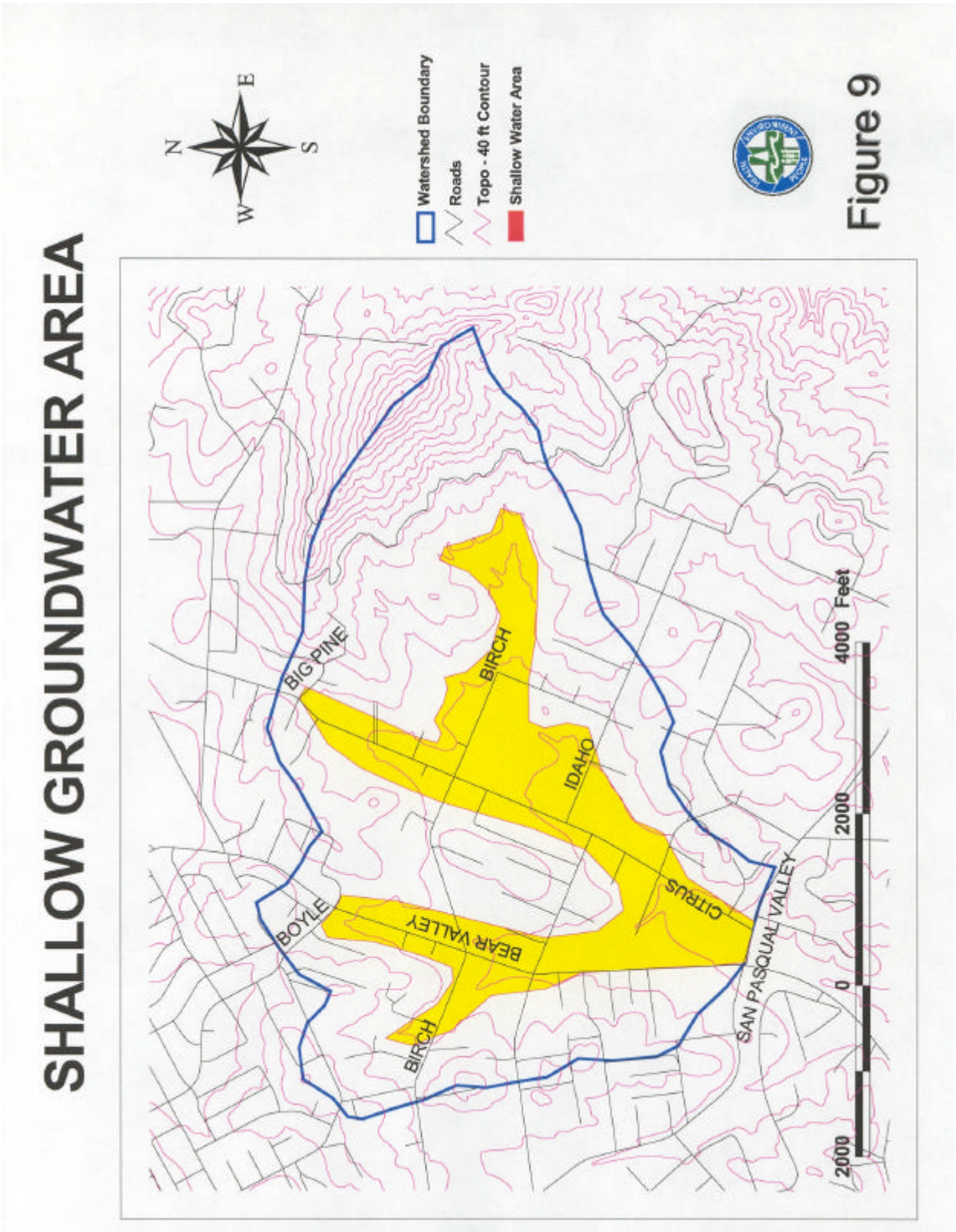
Based on the groundwater recharge calculations, the following conclusions are reached:

- Under current conditions (Scenario 1), the total annual average recharge is 283 acre-feet. The current residential and agricultural uses within the watershed represent 52 percent of the watershed's total groundwater recharge.

- Under Scenario 2, the projected total annual recharge would be 305 acre-feet with the residential uses representing a total of 56 percent of the watershed's total recharge.

- Under Scenario 3, the projected total annual recharge would be 340 acre-feet with the residential uses representing a total of 71 percent of the watershed's total recharge.

- There are areas within the watershed that DEH currently considers unsuitable for installation of new septic systems. These areas are highlighted in yellow on Figure 9. It is expected that existing residences within these areas outlined will continue to experience periodic failures. It is expected that if development occurs as presented under Scenario 3 the duration of these failures maybe extended slightly.


SHALLOW GROUNDWATER AREA
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Watershed Boundary
Roads
Topo - 40 ft Contour
Shallow Water Area
Figure 9
BIG PINE
BIRCH
IDAHO
CITRUS
BEAR VALLEY
BOYLE
BIRCH
SAN PASQUAL VALLEY
2000
0
2000
4000 Feet

9. RECOMMENDATIONS

A. The high groundwater conditions within the study area are a result of several factors. These included shallow groundwater conditions due to proximity to natural and manmade drainages, septic systems and use of imported water. Of these factors, only the siting of future septic systems is within the authority and control of the Department of Environmental Health. This study has attempted to address the impacts of imported water and development within the watershed on siting new septic systems. With this in mind it is recommended that the current moratorium be lifted concurrently with the implementation of 1), 2) and 3) outlined below.

1) Due to shallow groundwater problems in the areas highlighted in yellow on Figure 9, DEH should establish a groundwater-monitoring program that should include, but not limited to the existing wells within the watershed.

   - The construction of these wells will need to be evaluated to determine if they will provide reliable water level information.

   - Monitoring should be completed quarterly.

   - This data would provide a source of long-term groundwater levels to assist DEH in evaluating future development proposals in the area with potential use in other similarly impacted areas in the county.

2) The Citrus Avenue watershed DEH must strictly enforce of the groundwater separation requirements on all new septic systems, as established by the San Diego Regional Water Quality Control Board and contained in DEH policies.

3) All proposed development within the areas highlighted in yellow on Figure 9, shall meet these additional requirements.

   - In addition to the standard percolation testing, subsurface aquifer testing will be required to determine the subsurface hydogeologic conditions on the site and in the proposed field area.

   - A comprehensive groundwater mounding study completed to demonstrate the impacts of the proposed septic system(s) on the groundwater on-site and off-site. This evaluation must show the proposed development will not cause a failure due to groundwater conditions on any of the proposed septic system(s) or any of the

existing septic system(s) surrounding the project. This study needs to be completed by a California Certified Hydro geologist.

- The groundwater monitoring data and the groundwater mounding study needs to demonstrate that proper groundwater separation can be maintained through normal average rainfall years similar to those found in the rainfall record for Escondido.

B. The use of a mound system should be allowed as an alternative to a septic system to achieve a proper groundwater separation. Mound systems require surface slopes of less than 12.5 percent.

C. DEH develop a countywide policy that establishes the testing and investigation requirements for projects that are proposed in areas where shallow groundwater conditions present problems with installation of septic systems. The policy needs to be designed with the flexibility to allow areas of concern to be modified, added or deleted by the director or by the Division Chief when new information is available.

D. The currently developed lots that have had historical problems with septic system failures are expected to continue to have failures unless a long-term solution can be implemented. Currently there is only one long-term permanent solution for these developed properties are connecting to public sewer.

E. A large number of the historical failures are situated along the northern portions of both Bear Valley Parkway and Citrus Avenue. These failures appear to be due to the existing systems being installed in the area of the historical drainage swale for the area. Currently the surface drainage has been rerouted along Bear Valley Parkway and Citrus Avenue.

   The improved drainage today consists of unlined road ditches with some of the areas these ditches having limited capacity. As a result in wet weather conditions localized flooding occurs resulting in the flooding of residences and the existing leach fields.

   It is recommended that the County Department of Public Works evaluate and improve the surface drainage structures and/or improvements along both Bear Valley Parkway and Citrus Avenue. Modification of these improvements should focus on prevention of runoff infiltration and the potential of flooding in the area of the existing septic systems that have experienced failures.

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